



**(43) International Publication Date**  
**12 December 2002 (12.12.2002)**

**(10) International Publication Number**  
**WO 02/099976 A3**

## PCT

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| <p><b>(51) International Patent Classification<sup>7</sup>:</b> <b>H03M 13/25, G06F 11/00</b></p> <p><b>(21) International Application Number:</b> <b>PCT/US02/06897</b></p> <p><b>(22) International Filing Date:</b> <b>8 March 2002 (08.03.2002)</b></p> <p><b>(25) Filing Language:</b> <b>English</b></p> <p><b>(26) Publication Language:</b> <b>English</b></p> <p><b>(30) Priority Data:</b><br/> 60/296,223                      6 June 2001 (06.06.2001)    US<br/> 60/314,987                      24 August 2001 (24.08.2001)    US</p> <p><b>(71) Applicant:</b> <b>SEAGATE TECHNOLOGY LLC [US/US];</b><br/> 920 Disc Drive, Scotts Valley, CA 95066 (US).</p> <p><b>(72) Inventors:</b> <b>KURTAS, Erozan;</b> 910 Bingham Street, Unit J, Pittsburgh, PA 15203 (US). <b>KUZNETSOV, Alexander, V.;</b> 6417 Kentucky Avenue, Pittsburgh, PA 15206 (US). <b>VASIC, Bane;</b> 4841 N. Valley View Road, Tucson, AZ 85718 (US).</p> <p><b>(74) Agent:</b> <b>BORDAS, Carol, I.;</b> Seagate Technology LLC, 1251 Waterfront Place, Pittsburgh, PA 15222 (US).</p> | <p><b>(81) Designated States (<i>national</i>):</b> AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW.</p> <p><b>(84) Designated States (<i>regional</i>):</b> ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Declarations under Rule 4.17:</b><br/> — <i>as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS,</i></p> |
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*[Continued on next page]*

- (54) Title: A METHOD AND CODING APPARATUS USING LOW DENSITY PARITY CHECK CODES FOR DATA STORAGE OR DATA TRANSMISSION**

## Structure of the new LDPC codes

**Parity check matrix:**  $n$ - code length,  $k$  - number of user bits, redundancy  $r=n-k$

Diagram illustrating a matrix  $H$  (10 rows by 10 columns) divided into three sections: 302, 304, and 306. The matrix is composed of binary values (0 and 1). The number of base blocks  $t$  is indicated at the bottom.

1	0	0	.	0	0	1	0	0	.	0	0		1	0	1	.	0	0
1	1	0	.	1	0	0	1	0	.	1	0		0	1	0	.	1	0
0	1	1	.	0	1	0	0	1	.	0	1		0	0	1	.	1	1
0	0	1	.	0	0	1	0	0	.	0	0		0	0	0	.	0	1
0	0	0	.	1	0	0	1	0	.	1	0		0	0	0	.	1	0
.	.	.	.	.	.	.	.	.	.	.	.		.	.	.	.	.	
1	0	0	.	0	1	1	0	0	.	0	0		1	0	0	.	0	0
0	1	0	.	0	0	0	1	0	.	1	0		1	1	0	.	0	0
0	0	1	.	0	0	0	0	1	.	0	1		0	1	1	.	0	0

Number of base blocks  $t$

**Example: Kirkman 163:  $J=3$ ,  $m=163$ ,  $t=27$ ,  $n=mt=4401$**

- (57) Abstract:** A method of generating low density parity check codes for encoding data includes constructing a parity check matrix  $H$  from balanced incomplete block design (BIBD) in which a plurality  $B$ -sets which define the matrix have no more than one intersection point. The parity bits are then generated as a function of the constructed parity check matrix  $H$ .



*MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

**Published:**

— *with international search report*

**(88) Date of publication of the international search report:**

27 February 2003

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 02/06897

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H03M13/25 G06F11/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H03M G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>BOND J W ET AL: "Constructing low-density parity-check codes with circulant matrices"</p> <p>INFORMATION THEORY AND NETWORKING WORKSHOP, 1999 METSOVO, GREECE 27 JUNE-1 JULY 1999, PISCATAWAY, NJ, USA, IEEE, US, 27 June 1999 (1999-06-27), page 52</p> <p>XP010365561</p> <p>ISBN: 0-7803-5954-2</p> <p>paragraph '00II!</p> <p style="text-align: center;">--- -/--</p>	1-5

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

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- \*E\* earlier document but published on or after the international filing date
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- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*G\* document member of the same patent family

Date of the actual completion of the international search

11 July 2002

Date of mailing of the international search report

19/07/2002

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Gerdes, R

## INTERNATIONAL SEARCH REPORT

Internati plication No  
PCT/US 02/06897

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>ZHAO S ET AL: "Application of Kirkman designs in joint detection multiple access schemes", SPREAD SPECTRUM TECHNIQUES AND APPLICATIONS PROCEEDINGS, 1996., IEEE 4TH INTERNATIONAL SYMPOSIUM ON MAINZ, GERMANY 22-25 SEPT. 1996, NEW YORK, NY, USA, IEEE, US, PAGE(S) 857-861 XP010208706 ISBN: 0-7803-3567-8 abstract paragraph '000I!</p> <p>---</p>	1-18
A	<p>MACKAY D J C: "Good error-correcting codes based on very sparse matrices" IEEE TRANSACTIONS ON INFORMATION THEORY, IEEE INC. NEW YORK, US, vol. 45, no. 2, March 1999 (1999-03), pages 399-431, XP002143042 ISSN: 0018-9448 page 402, paragraph IIA</p> <p>---</p>	1-18
A	<p>US 4 295 218 A (TANNER ROBERT M) 13 October 1981 (1981-10-13) column 32, line 25 -column 33, line 2</p> <p>---</p>	1-18
A	<p>POTHIER O ET AL: "A low complexity FEC scheme based on the intersection of interleaved block codes" VEHICULAR TECHNOLOGY CONFERENCE, 1999 IEEE 49TH HOUSTON, TX, USA 16-20 MAY 1999, PISCATAWAY, NJ, USA, IEEE, US, 16 May 1999 (1999-05-16), pages 274-278, XP010342026 ISBN: 0-7803-5565-2 abstract</p> <p>-----</p>	1-18

## INTERNATIONAL SEARCH REPORT

### Information on patent family members

International	Application No
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PCT/US 02/06897

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4295218	A	13-10-1981	NONE